

A Review of the Family Embolemidae (Hymenoptera: Chrysidoidea) from South Korea

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ABSTRACT

Previously only one species, *Embolemus ruddii* Westwood, 1833, of the family Embolemidae has been recorded in South Korea. As part of a recent study of this family, we newly report four species from South Korea: *Embolemus hachijoensis* Hirashima et Yamagishi, 1975; *E. krombeini* Olmi, 1996; *E. sensitivus* Xu, Olmi et Guglielmino, 2012; *Ampulicomorpha thauma* Rasnitsyn et Matveev, 1989. The genus, *Ampulicomorpha* Ashmead, 1893, is recorded for the first time in South Korea. *Embolemus ruddii* was previously recorded from South Korea because considered synonym of *E. walkeri*. However, in recent years the two species were separated and *E. ruddii* was considered absent in the far east, where on the contrary *E. walkeri* is present. Therefore, five species in two genera are now recognized as the South Korean embolemid fauna. A key to the South Korean Embolemidae species is provided.

Keywords: *Ampulicomorpha*, *Embolemus*, key, new records, taxonomy

INTRODUCTION

Embolemidae Förster, 1856, one of the families within the superfamily Chrysidoidea, consists of 106 valid species distributed in three valid genera of the world: *Embolemus* Westwood, 1833; *Ampulicomorpha* Ashmead, 1893; *Trogloembolemus* Olmi, Mita & Guglielmino, 2014 (Olmi et al., 2014b). In East Asia, eight species of two genera (*Embolemus*, *Ampulicomorpha*) are recorded from China, seven species of two genera (*Embolemus*, *Trogloembolemus*) are recorded from Japan and two species of one genus (*Embolemus*) are recorded from the Russian Far East (Xu et al., 2001, 2012a, 2012b; Olmi et al., 2014a, 2014b).

As natural enemies, members of the Embolemidae are known to be parasitoids of the nymphs of planthoppers (Hemiptera: Auchenorrhyncha): *Embolemus* is parasitoid of nymphs of Cixiidae living in the soil and feeding on roots; *Ampulicomorpha* is parasitoid of nymphs of Achilidae living in rotten logs and feeding on hyphal sheets of shelf fungi; the biology of *Trogloembolemus* is unknown (Bridwell, 1958; Wharton, 1989; Olmi, 1996; Varrone and Olmi, 2012; Guglielmino and Bückle, 2013; Olmi et al., 2014b).

Previously only one species, *Embolemus ruddii* Westwood, 1833, has been recorded from South Korea (Lee and Kim,

2010). As a part of our recent studies on the South Korean Embolemidae, we report four species new to South Korea and *E. ruddii* recorded from South Korea was regarded as *E. walkeri*. A key to South Korean embolemid is also provided.

MATERIALS AND METHODS

The morphological terms used in the present study follow Olmi (1994, 1996, 1999). The images were captured with an AxioCam HRc camera through a Discovery V20 stereomicroscope and produced with the AxioVision40AC software (Carl Zeiss, Oberkochen, Germany). Final plates of illustrations were prepared in Adobe Photoshop CS6.

Abbreviations are as follows: BMNH, The Natural History Museum, London, UK; OL, distance between the inner edges of a lateral ocellus and the median ocellus; OOL, distance from the outer edge of a lateral ocellus to the compound eye; OPL, distance from the posterior edge of a lateral ocellus to the occipital carina; POL, distance between the inner edges of two lateral ocelli; TL, distance from the posterior edge of an eye to the occipital carina; BC, basal cell; CC, costal cell; SBC, sub-basal cell; 1DC, first discal cell; 1SDC, first sub-discal cell; MT, Malaise Trap; PT, Pitfall Trap; YPT, Yellow



Fig. 1. *Ampulicomorpha thauma* Rasnitsyn et Matveev, 1989 (female). A, Habitus in lateral view; B, Head in lateral view; C, Head in frontal view; D, Head and mesosoma in dorsal view. Scale bars: A=0.5 mm, B, C=0.1 mm, D=0.2 mm.

Pan Trap.

The material studied in the present paper is deposited at the Yeungnam University (YNU), Gyeongsan, South Korea.

SYSTEMATIC ACCOUNTS

Order Hymenoptera Linnaeus, 1758
Family Embolemidae Förster, 1856

¹*Genus *Ampulicomorpha* Ashmead, 1893
Ampulicomorpha Ashmead, 1893: 79.
Ampulicomorpha (sic!) Ashmead: Brues, 1933: 114.

Type species. *Ampulicomorpha confusa* Ashmead, 1893, original designation.

Diagnosis. Macropterous; fore wing usually with 1SDC cell fully enclosed by pigmented veins (or partly open); palpal formula 6/3, 6/2, or 5/2; tibial spurs 1/2/2; female antennal segment 1 much longer than segment 3; male antennal segment 1 usually shorter than segment 3.

²***1. *Ampulicomorpha thauma* Rasnitsyn et Matveev, 1989 (Fig. 1)**

Ampulicomorpha thauma Rasnitsyn et Matveev, 1989: 657.
Ampulicomorpha hachijoensis Hirashima & Yamagishi: Olmi, 1996: 99.

Korean name: ¹*날개벌구살이벌속, ²*날개벌구살이벌

Material examined. South Korea: 1 ♀, Gyeongsangbuk-do: Gyeongsan-si, Dae-dong, Yeungnam Univ., 35°58'N, 128°47'E, 12–21 Jul 2007 (MT), Lee JW leg. (YNU); 1 ♀, Cheongdo-gun, Gakbuk-myeon, Namsan-ri, 35°38'N, 128°47'E, 5–29 Jul 2010 (MT), Lee JW leg. (YNU); 1 ♀, ditto, 20 Jun–3 Jul 2011 (MT), Lee JW leg. (YNU); 1 ♀, Cheongsong-gun, Mt. Juwangsan, Jusanji, 6 Sep–13 Oct 2008 (MT), Jeong JC leg. (YNU).

Diagnosis of female. Body length 3.72–4.34 mm. Macropterous. Head, mesosoma and metasoma dark brown except propodeum and metapleuron blackish brown; mandible, antenna, legs yellowish brown to brown. Antennal segments in following proportions: 30 : 8 : 18 : 18 : 18 : 16 : 15 : 15 : 19. Head dull, covered with short hairs; occipital carina complete; POL: 3; OL: 4; OOL: 9; OPL: 5; TL: 13; eye very small, approximately 0.29 times as long as head (17 : 58); region of face from clypeus to antennal toruli with two very convergent longitudinal and median sutures visible (upper half of sutures hardly visible). Pronotum dull, covered with short hairs and complete median longitudinal furrow. Notauli absent. Parapsidal lines distinctly visible near lateral margins of scutum. Propodeum dull, reticulate rugose, with two median longitudinal keels from anterior margin to posterior surface. Fore wing hyaline, without dark transverse bands; 1SDC cell partly open, not fully enclosed by pigmented veins.

Male. Unknown.

Host. Unknown.

Distribution. South Korea (new record), Russia (European).

¹*Genus *Emblemus* Westwood, 1833

Emblemus Westwood, 1833a: 444.

Myrmecomorphus Westwood, 1833b: 496.

Polyplanus Nees von Esenbeck, 1834: 349.

Pedinomma Förster, 1856: 94.

Type species. *Emblemus ruddii* Westwood, 1833, by monotypy.

Diagnosis. Female: Usually micropterous, occasionally brachypterous; head pyriform; maxillary palpus with 3–5 segments; labial palpus with two segments; ocelli absent; pronotum without or with trace of a median furrow. Male: Fully winged; fore wing usually with costal, basal, subbasal and first discal cells fully enclosed by pigmented veins; first subdiscal cell not fully enclosed by pigmented veins, partly open; head not pyriform; pronotum without or with trace of a median longitudinal furrow; maxillary palpus with 3–6 segments; labial palpus with 2–3 segments. Ocelli distinct.

²***2. *Emblemus hachijoensis* Hirashima et Yamagishi, 1975 (Figs. 2, 6C)**

Emblemus hachijoensis Hirashima & Yamagishi, 1975: 29.
Ampulicomorpha hachijoensis (Hirashima & Yamagishi): Olmi, 1996: 100, part., ♂ (except specimens from Taiwan).

Material examined. South Korea: 1 ♂, Gangwon-do: Donghae-si, Samhwa-dong, Mureung valley, 11–21 Jul 2006 (MT), Lee JW leg. (YNU); 1 ♂, Gyeonggi-do: Osan-si, Geumam-dong, Mulhyanggi Arboretum, Alt. 38 m, 37°10'3.1"N, 127°03'24.2"E, 16 Apr–31 Aug 2012 (MT), Kwon YD, Ji YM (YNU); 1 ♂, Gyeongsangbuk-do: Gyeongsan-si, Dae-dong, Yeungnam Univ., 35°58'N, 128°47'E, 1–24 Mar 2012 (MT), Lee JW leg. (YNU); 1 ♂, Gyeongju-si, Hyeongok-myeon, Namsa-ri, 15–29 Sep 2005 (MT), Mun JT leg. (YNU); 1 ♂, Jeju-si, Ara-1-dong, Jeju Univ., 4–11 Nov 2008 (MT), Lee JW leg. (YNU).

Diagnosis of male. Body length 1.90–3.20 mm. Macropterous. Head, mesosoma and metasoma brown or dark brown; antenna brown, except segments 1–2 yellow, or dark brown, except segments 1–2 brown; clypeus, mandible, legs yellow or yellowish brown. Antennal segments in following proportions: 32 : 8 : 41 : 38 : 36 : 36 : 32 : 32 : 30 : 38. Head dull, covered with short hairs; occipital carina complete; POL: 13; OL: 12; OOL: 28; OPL: 20; TL: 40; eye small, approximately 0.46 times as long as head (21 : 45); region of face from clypeus to antennal toruli with two distinct longitudinal and median sutures. Pronotum dull, without track of median longitudinal furrow. Notauli incomplete, hardly visible near anterior margin of scutum. Parapsidal lines distinctly visible near lateral margins of scutum. Propodeum dull, reticulate rugose, with two median longitudinal keels from anterior margin to posterior surface. Fore wing hyaline, without dark transverse bands; 1SDC cell almost completely enclosed by pigmented veins or partly open, not fully enclosed by pigmented veins. Dorsal membranous process of paramere with mosaic drawing, without papillae.

Female. Unknown.

Host. Unknown.

Distribution. South Korea (new record), Japan.

³***3. *Emblemus pecki* Olmi, 1997 (Figs. 3, 6A)**

Emblemus walkeri Richards partim: Yasumatsu, 1960: 25 (male paratypes of *E. walkeri*).

Emblemus walkeri Richards: Hirashima & Yamagishi, 1975: 27 (all males of *E. walkeri*, except one male from Japan, Kamiozoegawa).

Emblemus ruddii Westwood: Olmi, 1996: 112, part (only some specimens from Taiwan and Japan).

Korean name: ¹*멸구살이벌속, ²*민멸구살이벌, ³*돌기멸구살이벌

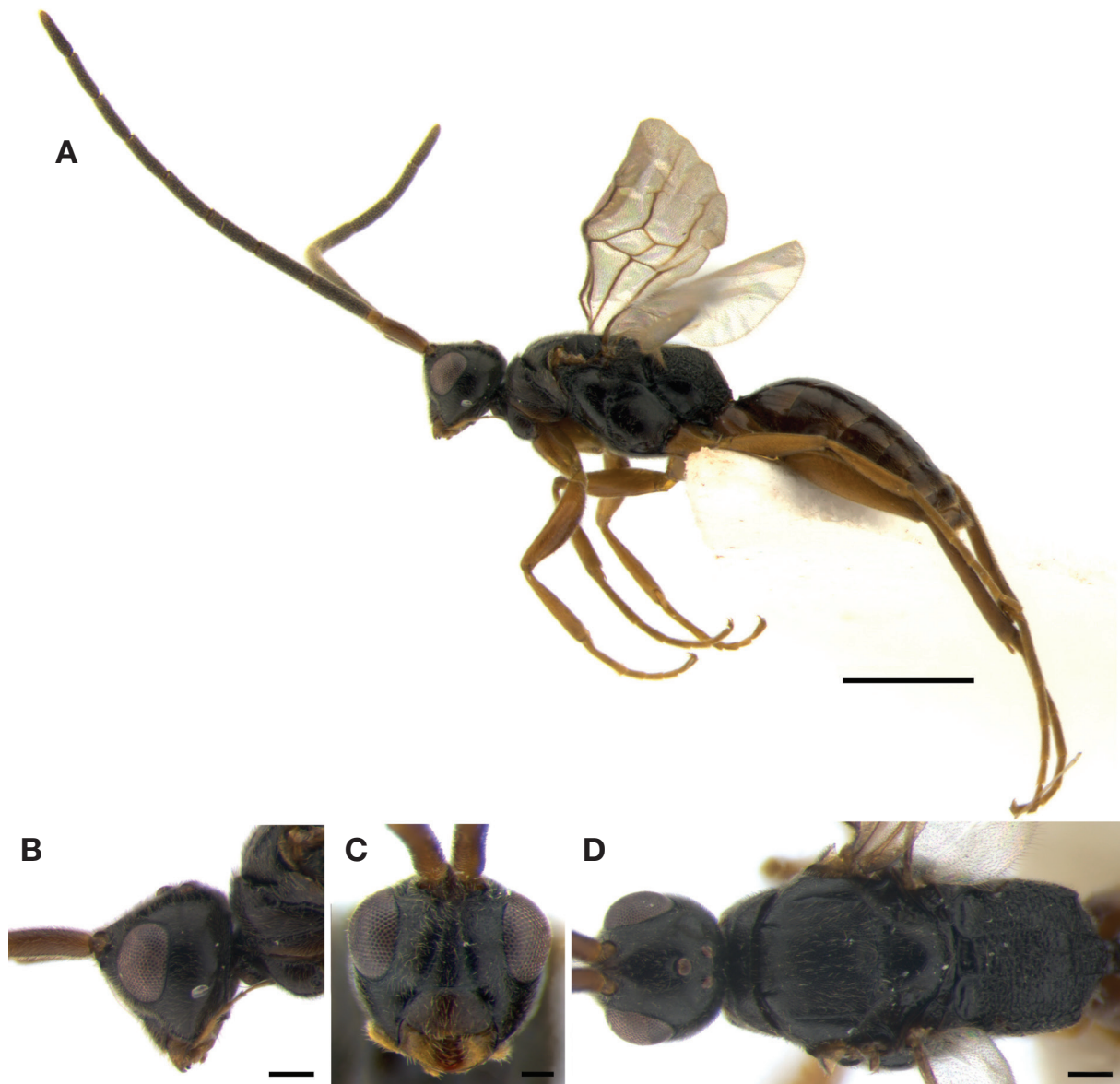


Fig. 2. *Embolemus hachijoensis* Hirashima et Yamagishi, 1975 (male). A, Habitus in lateral view; B, Head in lateral view; C, Head in frontal view; D, Head and mesosoma in dorsal view. Scale bars: A=1.0 mm, B, D=0.2 mm, C=0.1 mm.

Embolemus krombeini Olmi, 1996: 123, part.
Embolemus pecki Olmi, 1997: 139.

Material examined. South Korea: 2♂♂, Gyeonggi-do: Namyangju-si, Choan, Songchon, Mt. Ungilsan, 37°34'43.2" N, 127°18'40.1"E, 19 Sep–15 Oct 2009 (MT), Lim JO leg. (YNU).

Diagnosis of male. Body length 3.18–3.67 mm. Macropterous. Head dark brown except clypeus and mandible yellowish brown; mesosoma and metasoma brown; antenna and legs yellowish brown. Antennal segments in following pro-

portions: 20 : 6 : 45 : 45 : 40 : 39 : 34 : 35 : 32 : 35. Head shiny, covered with short hairs; occipital carina complete; POL: 5; OL: 6; OOL: 14; OPL: 12; TL: 16; eye small, approximately 0.40 times as long as head (21 : 53); region of face from clypeus to antennal toruli with two distinct longitudinal and median sutures. Pronotum very short, partly hidden behind occiput, with complete median longitudinal furrow. Notauli incomplete, reaching approximately 0.20 × length of scutum. Parapsidal lines visible near lateral margins of scutum. Propodeum dull, rugose to reticulate rugose, without longitudinal keels. Fore wing hyaline, without dark transverse bands,

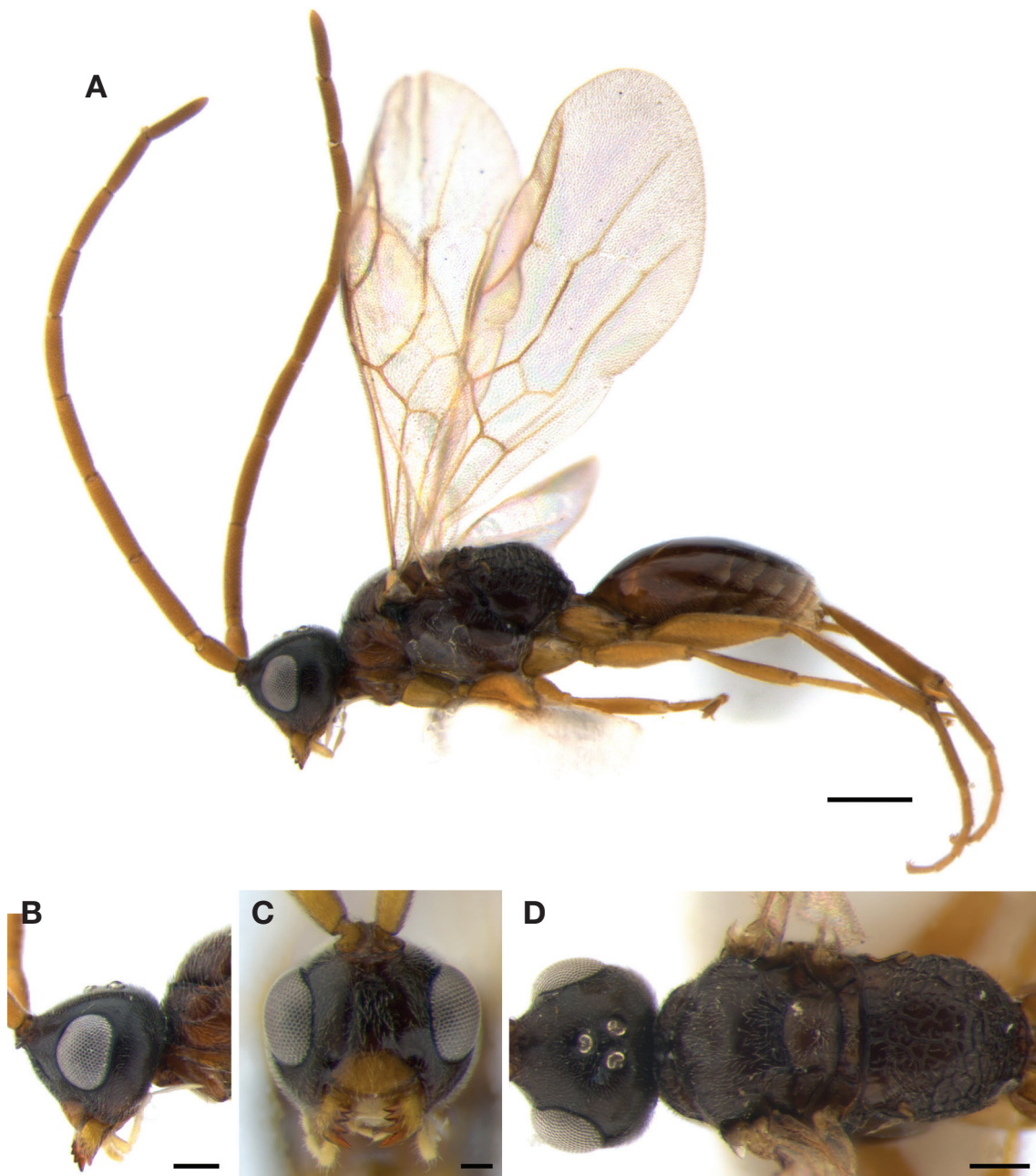


Fig. 3. *Embolemus pecki* Olmi, 1997 (male). A, Habitus in latera view I; B, Head in lateral view; C, Head in frontal view; D, Head and mesosoma in dorsal view. Scale bars: A=0.5 mm, B, D=0.2 mm, C=0.1 mm.

with four cells fully enclosed by pigmented veins (CC, BC, SBC, 1DC). Proximal membranous process of paramere with numerous papillae on distal region.

Female. Unknown.

Host. Unknown.

Distribution. South Korea (new record), China, Indonesia,

Japan, Russia (Far East), Spain, Vietnam.

¹***4. *Embolemus sensitivus* Xu, Olmi et Guglielmino, 2012 (Figs. 4, 6B)**

Embolemus walkeri Richards: Yasumatsu, 1960: 25, part., ♂, allotype of *E. walkeri*.

Korean name: ¹*수염벌구살이벌

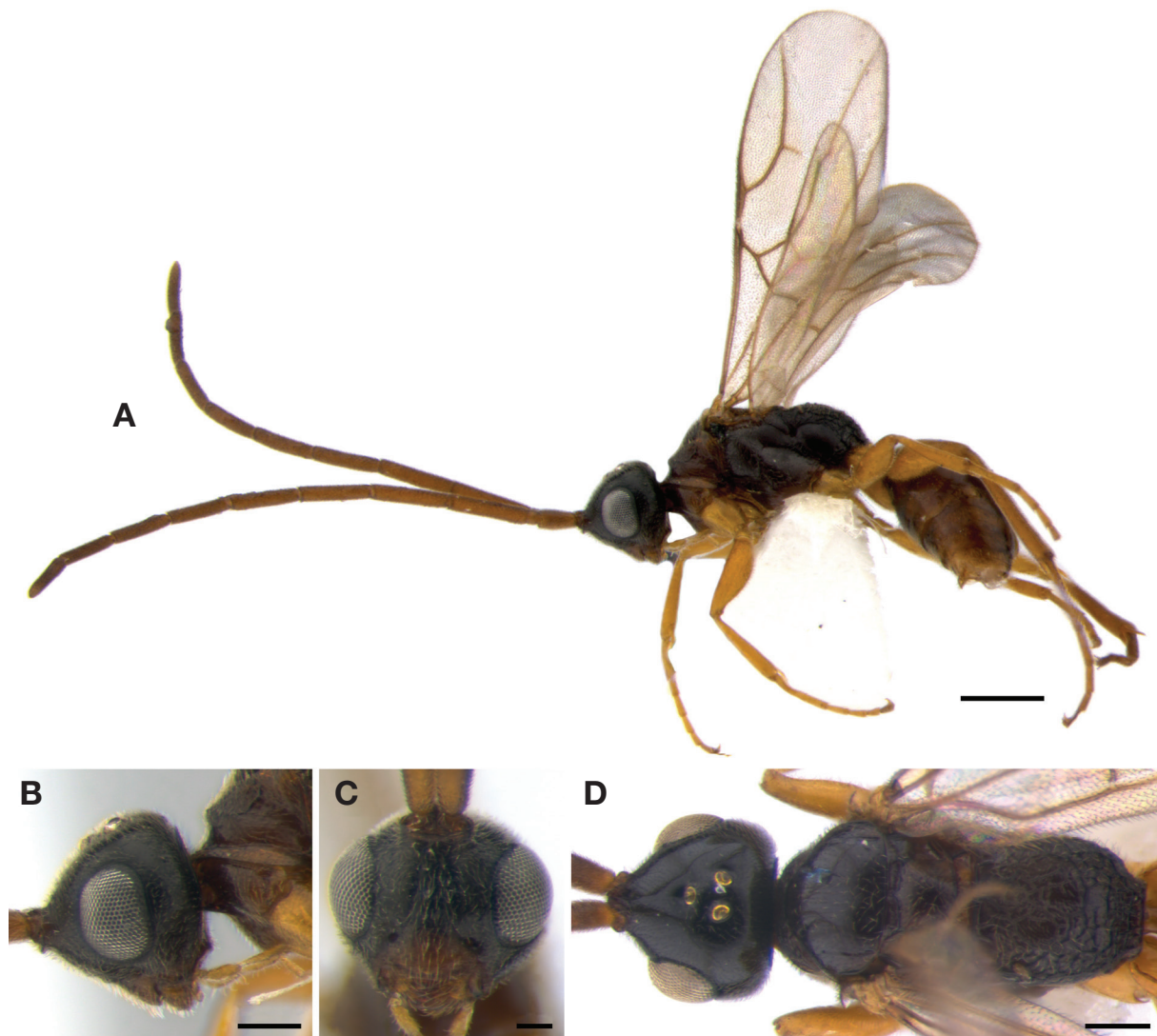


Fig. 4. *Embolemus sensitivus* Xu, Olmi et Guglielmino, 2012 (male). A, Habitus in lateral view; B, Head in lateral view; C, Head in frontal view; D, Head and mesosoma in dorsal view. Scale bars: A=0.5 mm, B, D=0.2 mm, C=0.1 mm.

Embolemus walkeri Richards: Hirashima & Yamagishi, 1975: 27, part., ♂ from Japan, Kamiozoegawa.
Embolemus sensitivus Xu et al., 2012a: 1118.

Material examined. South Korea: 2♂♂, Gangwon-do: Donghae-si, Samhwa-dong, Mureung valley, 15 Jul–1 Aug 2005 (MT), Lee JW leg. (YNU); 1♂, Inje-gun, Girin-myeon, Mt. Bantaesan, 27 Aug–26 Sep 2013 (MT), Park JY leg. (YNU); 1♂, Gyeonggi-do: Osan-si, Geumam-dong, Mulhyanggi Arboretum, Alt. 38 m, 37°10'3.1"N, 127°03'24.2"E, 16 Apr–31 Aug 2012 (MT), Kwon YD, Ji YM (YNU); 2♂♂, Nanyangju-si, Choan, Songchon, Mt. Ungilsan, 37°34'43.2"N, 127°18'40.1"E, 26 Jun–16 Jul 2009 (MT), Lim JO leg. (YNU); 1♂, Jeju-do: Seogwipo-si, Namwon-eup, Harye-ri,

Hyoryegyo, 33°15'49"N, 126°37'28"E, 7 Aug 2013 (YPT), Kim KB leg. (YNU).

Diagnosis of male. Body length 2.99–3.77 mm. Macropterous. Head dark brown except clypeus and mandible brown; mesosoma and metasoma brown; antenna brown; legs yellowish brown. Antennal segments in following proportions: 18 : 6 : 40 : 38 : 35 : 33 : 31 : 30 : 29 : 32. Head shiny, covered with short hairs; occipital carina complete; POL: 5; OL: 5; OOL: 11; OPL: 10; TL: 12; eye small, approximately 0.46 times as long as head (21 : 46); region of face from clypeus to antennal toruli with two distinct longitudinal and median sutures. Pronotum very short, with complete median longitudinal furrow. Notauli incomplete, reaching approximately 0.35 × length of scutum. Parapsidal lines distinctly visible



Fig. 5. *Embolemus walkeri* Richards, 1951 (female). A, Habitus in lateral view; B, Head in lateral view; C, Head in frontal view; D, Head and mesosoma in dorsal view. Scale bars: A=0.5 mm, B, D=0.2 mm, C=0.1 mm.

near lateral margins of scutum. Propodeum dull, reticulate rugose, with two median longitudinal keels from anterior margin to posterior surface. Fore wing hyaline, without dark transverse bands; 1SDC cell open. Proximal membranous process of paramere with many sensorial filaments located on distal and subdistal region, without papillae.

Female. Unknown.

Host. Unknown.

Distribution. South Korea (new record), China, Japan, Russia (Far East), Vietnam.

¹***5. *Embolemus walkeri* Richards, 1951 (Fig. 5)**

Embolemus walkeri Richards, 1951: 814.

Embolemus ruddii Westwood: Olmi, 1996: 114; Lee and Kim, 2010: 146.

Holotype material examined. China: 1 ♀, Zhejiang, near Ning Po (= Ningbo), Da-Laen-Saen, 1500–2500 ft., 5–16

Nov 1892, with ants, Walker JJ leg. (Cruis of the Penguin) (BMNH).

Other material examined. South Korea: 1 ♀, Gyeongsangnam-do: Miryang-si, Mijeon-ri, 36°32'06"N, 127°49'40"E, 19 Apr–2 May 2008 (PT), Hong EJ leg. (YNU).

Diagnosis of female. Body length 3.20 mm. Micropterous. Head, mesosoma, metasoma, antenna, legs yellowish brown to brown. Antennal segments in following proportions: 45 : 10 : 18 : 20 : 20 : 18 : 17 : 15 : 15 : 20. Head dull, covered with short hairs; occipital carina complete; ocelli absent; eye very small, approximately 0.19 times as long as head (5 : 26); region of face from clypeus to antennal toruli with two distinct longitudinal and median sutures. Pronotum dull, granulate, covered with short hairs, crossed by strong anterior transverse impression, with two fine lateral incomplete carinae beginning at posterior border and reaching about 0.5 × length of pronotum; anterior collar very short; disc long, without median longitudinal groove. Scutum small, subrec-

Korean name: ¹*멸구살이벌

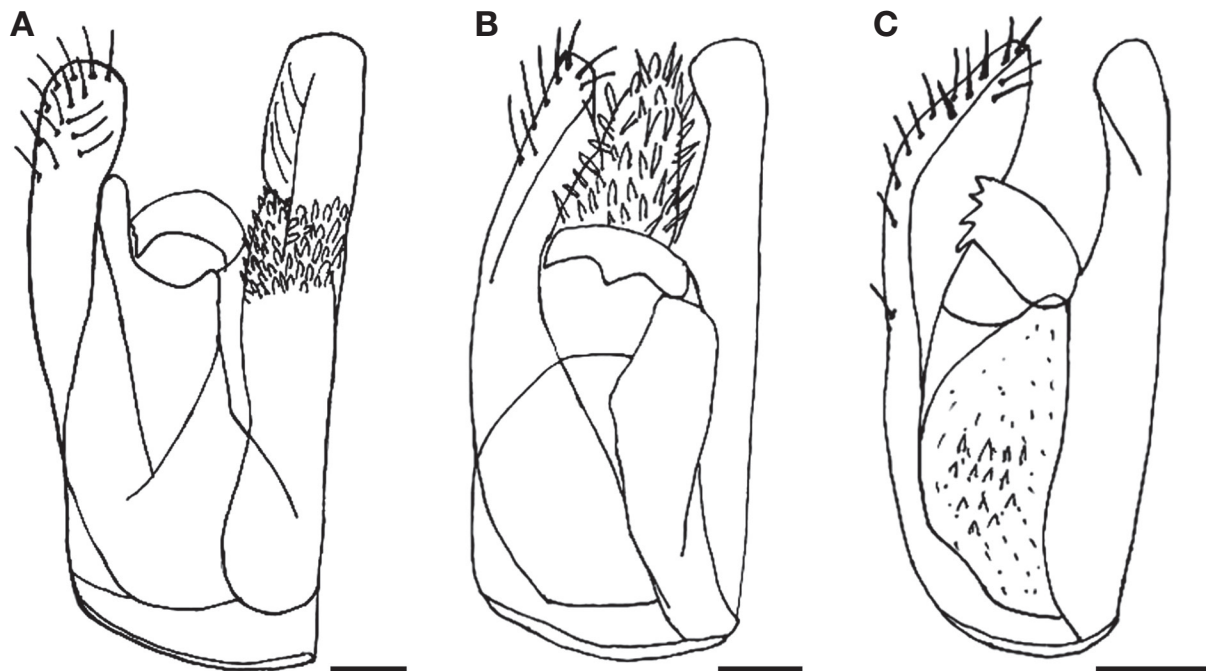


Fig. 6. Male genitalia in dorsal view (right half removed). A, *Embolemus pecki*; B, *E. sensitivus*; C, *E. hachijoensis*. Scale bars: A–C=0.05 mm.

tangular, granulate. Notauli absent. Parapsidal lines present, hardly visible near lateral margins of scutum. Propodeum with spiracles normally prominent; anterior dorsal surface flat, granulate to weakly rugose; posterior surface granulate with transverse striae; Fore wing strongly reduced, slightly longer than tegula, hind wing absent.

Male. Unknown.

Host. Unknown.

Distribution. China, Japan, South Korea.

Remark. Until now, only one species, *Embolemus ruddii* (Westwood), belonging to the family Embolemidae was listed in South Korea (Lee and Kim, 2010). *Embolemus walkeri* in fact was synonymized with *E. ruddii* by Olmi (1996) at that time. However, afterwards Olmi et al. (2014b) separated these two species: *E. walkeri* (mainly present in the Eastern Palaearctic region, except only Zhejiang, China [Oriental region]) and *E. ruddii* (mainly present in Western Palaearctic region, except only Eastern Siberia [Eastern Palaearctic region]). Therefore, the first author directly examined the type and non-type specimens of these two species in BMNH and we reconfirmed that *E. walkeri* is distributed in South Korea (South Korean specimen and the holotype of *E. walkeri* are characterized by a median depression of the propodeum located at the border between anterior flat surface and posterior inclined surface, whereas in *E. ruddii* the propodeum has no median depression [see figures 4C and 5C in Olmi et

al., 2014b]).

Key to the species of South Korean Embolemidae

Females (unknown in the species absent in the key)

1. Macropterous (Fig. 1A) *Ampulicomorpha thauma* Rasnitsyn et Matveev
- Micropterous (Fig. 5A, D) *Embolemus walkeri* Richards

Males (unknown in the species not present in the key)

1. Proximal membranous process of paramere with mosaic drawing, without papillae and sensorial filaments (Fig. 6C) *Embolemus hachijoensis* Hirashima et Yamagishi
- Proximal membranous process of paramere with papillae or sensorial filaments 2
2. Proximal membranous process of paramere with papillae (Fig. 6A) *Embolemus pecki* Olmi
- Proximal membranous process of paramere with sensorial filaments, without papillae (Fig. 6B) *Embolemus sensitivus* Xu, Olmi et Guglielmino

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